

TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No. - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



2 of 14

3. PROOF OF CONCEPTION ALL EVIDENCE OF CONCEPTION (FIRST DRAWING AND FIRST WRITTEN DESCRIPTION) AND EVIDENCE OF REDUCTION TO PRACTICE (DEVICE EMBODYING THE INVENTION AND TEST DATA) MUST BE RETAINED.

A BY WHOM WAS FIRST DESCRIPTION WRITTEN OR DRAWING MADE? Joe Colburn	DATE	TIME SPENT 2 hours	ACCT. CHARGED RGM23V94	LOCATION OF FIRST DESCRIPTION/DRAWING Colburn's hard disk
B TO WHOM WAS INVENTION FIRST DISCLOSED? Jonathan Lynch				DATE

4. REDUCTION TO PRACTICE

A WAS A DEVICE EMBODYING THE INVENTION CONSTRUCTED AND TESTED OR THE PROCESS PRACTICED? <input checked="" type="radio"/> Yes <input type="radio"/> No	BY WHOM Joe Colburn	DATE STARTED	DATE COMPLETED	TIME SPENT 2 hours
B ACCOUNT CHARGED - TIME RGM23V94	ACCOUNT CHARGED - MATERIAL RGM23V94		PRESENT LOCATION OF DEVICE 250/2452	
C PRESENT LOCATION OF DOCUMENTS (DATE SIGNED AND WITNESSED), INCLUDING PHOTOS, DRAWINGS, AND DATA SHEETS SHOWING REDUCTION TO PRACTICE				

5. RELATION TO GOVERNMENT CONTRACT

A DOES THIS INVENTION RELATE TO WORK PERFORMED UNDER A GOVERNMENT CONTRACT? <input type="radio"/> Yes <input checked="" type="radio"/> No	CONTRACT NUMBER AND TITLE
B EXPLAIN HOW THIS INVENTION RELATES TO A GOVERNMENT CONTRACT:	
C IS INVENTION BEING USED ON A GOVERNMENT CONTRACT? <input type="radio"/> Yes <input checked="" type="radio"/> No	CONTRACT NUMBER AND TITLE

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

SIGNATURE OF INVENTOR <i>Joe Colburn</i>	DATE	SIGNATURE OF INVENTOR <i>Joe Colburn</i>	DATE	INVENTION DOCKET NO. RECEIVED HRL LABORATORIES, LLC <div style="border: 1px solid black; padding: 10px; text-align: center;"> 020603 </div>
SIGNATURE OF INVENTOR <i>Don Scarpino</i>	DATE	SIGNATURE OF INVENTOR <i>Don Scarpino</i>	DATE	
SIGNATURE OF INVENTOR	DATE	SIGNATURE OF INVENTOR	DATE	
SIGNATURE OF INVENTOR	DATE	SIGNATURE OF INVENTOR	DATE	
SIGNATURE OF INVENTOR	DATE	SIGNATURE OF INVENTOR	DATE	
READ AND UNDERSTOOD BY: ADE ORATONZO <i>ADE ORATONZO</i> <i>Don Scarpino</i> WITNESS NAME (TYPE) SIGNATURE DATE WITNESS NAME (TYPE) SIGNATURE DATE				

TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No. - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC

3 of M

6. RELATED DOCUMENTS AND DISCLOSURES (BY YOU OR BY ANOTHER). PLEASE ATTACH COPY.

A IS THERE A PUBLICATION OR PUBLIC PRESENTATION RELATED TO THE INVENTION?	<input type="radio"/> Yes <input checked="" type="radio"/> No	DATE	IDENTIFY
B ARE THERE ANY RELATED INVENTION DISCLOSURES OR PATENT APPLICATIONS?	<input type="radio"/> Yes <input checked="" type="radio"/> No	DATE	IDENTIFY PD NO. ETC.
C ARE THERE ANY PROPOSALS OR REPORTS OR OTHER DOCUMENTS RELATING TO THIS INVENTION?	<input checked="" type="radio"/> Yes <input type="radio"/> No	DATE	IDENTIFY GM Electrical Center monthly project review presentation.
D HAS THE INVENTION BEEN USED INSIDE OR OUTSIDE THE COMPANY, OR DISCUSSED, DEMONSTRATED, OR OTHERWISE DISCLOSED OUTSIDE THE COMPANY (SUCH AS TO A VENDOR OR CUSTOMER?)	<input checked="" type="radio"/> Yes <input type="radio"/> No	DATE	TO/FOR WHOM (COMPANY/PERSON) GM Electrical Center monthly project review.

7. SALE

A HAS PRODUCT EMBODYING INVENTION OR MADE BY INVENTION BEEN PROPOSED, SOLD, OR OFFERED FOR SALE?	<input type="radio"/> Yes <input checked="" type="radio"/> No	ORDER NO.	ORDER DATE	DELIVERY DATE	DATE OFFERED OR PROPOSED
B IS PRODUCT EMBODYING INVENTION OR MADE BY INVENTION IN A DELIVERABLE ITEM?	<input type="radio"/> Yes <input checked="" type="radio"/> No	DELIVERY DATE			

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

SIGNATURE OF INVENTOR		DATE		SIGNATURE OF INVENTOR		DATE		INVENTION DOCKET NO. RECEIVED HRL LABORATORIES, LLC V40000
SIGNATURE OF INVENTOR		DATE		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		DATE		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		DATE		SIGNATURE OF INVENTOR		DATE		

READ AND UNDERSTOOD BY:

ADG OBATOYWB0 [Signature]
WITNESS NAME (TYPE) SIGNATURE DATE

[Signature]
WITNESS NAME (TYPE) SIGNATURE DATE

[Signature]
SIGNATURE DATE

© 1999, 2000, 2001 HRL Laboratories, LLC

Rev: 05171

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



4 of 4

8. SUMMARY OF THE INVENTION

A. GIVE A BRIEF DESCRIPTION OF YOUR INVENTION, PARTICULARLY POINTING OUT WHAT IS BELIEVED TO BE NOVEL (THE "HEART" OF WHAT IS NEW).

This disclosure describes a low profile, dual band antenna that provides nearly omnidirectional, vertical polarization coverage in the azimuthal plane at both frequency of interest. The mechanisms that induce the two resonances of interest are fairly decoupled, which allows the two frequencies to be tuned independent of each other. The properties of this antenna make it an ideal candidate for terrestrial communication systems covering dual frequency bands. The application of particular interest is mobile phone systems that utilize both the AMPS (824 to 894 MHz) and PCS (1850 to 1990 MHz) frequency bands.

The starting point for the antenna described in this disclosure was an inductively loaded center fed patch antenna. The radiation pattern of this resonance is very similar to a monopole antenna, a vertically polarized pattern with a null perpendicular to the plane of the patch and a maximum in the plane of the patch. This is the ideal radiation pattern for most terrestrial communication systems.

Slots are introduced into the patch to generate the second resonance of interest. The slots are introduced in such a way as to create a planar inverted F antenna (PIFA). Although the PIFA pattern is not as ideal for terrestrial communication systems as the monopole pattern, it still provides a nearly uniform radiation intensity, vertically polarized radiation pattern in the azimuthal plane.

B. EXPLAIN THE PURPOSE AND ADVANTAGES OF YOUR INVENTION. (WHAT WILL THE INVENTION DO BETTER THAN DONE PREVIOUSLY?)

Most previously reports low profile, dual frequency antennas are patch antennas with slots introduced into the top surface. Unfortunately the radiation pattern of patch antennas, with a maximum in the radiation pattern perpendicular to the plane of the patch and nulls in the vertically polarized pattern in the plane of the patch, are not ideally suited for terrestrial communication systems. An additional benefit of the antenna described in this disclosure is that the short circuit allows it to be is smaller than traditional patch antennas

Dual frequency PIFA antennas have also been reported. Although these antennas have the size advantage of the antenna described in this disclosure, the monopole pattern of the low frequency resonance of the antenna described in this disclosure has an advantage for terrestrial communication systems. Also, the antenna described in this disclosure has more flexibility in selecting the dual frequencies of interest.

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR		INVENTION DOCKET NO. RECEIVED HRL LABORATORIES, LLC 020603	
 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR			
 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR			
 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR			
 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR			

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE) SIGNATURE DATE
 (EACH PAGE UPON WHICH INFORMATION IS ENTERED SHOULD BE SIGNED AND WITNESSED)

WITNESS NAME (TYPE) SIGNATURE DATE
 ©2001 HRL Laboratories, LLC. All rights reserved. Rev: 042501.

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RLSS
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



5 of 14

B. SUMMARY OF THE INVENTION (Continued)

C. IDENTIFY THE COMPANY OR OWNER PROGRAM OR PRODUCT LINE TO WHICH THE INVENTION APPLIES, AND THE EXPECTED VALUE TO THE PROGRAM OR PRODUCT LINE. ALSO IDENTIFY POTENTIAL COMMERCIAL APPLICATION OF THIS INVENTION, IF ANY.

This antenna has applications in wireless communication products that need a low profile, dual frequency radiating element that provides omnidirectional coverage in the plane of the antenna with a polarization perpendicular to the plane of the antenna. This antenna is ideally suited for GM's Onstar system that desires unobtrusive antennas to provide coverage of the AMPS and PCS terrestrial communication systems.

D. IDENTIFY THE PRIOR ART KNOWN TO YOU WHICH IS IMPROVED UPON OR DISPLACED BY YOUR INVENTION, AND STATE IN DETAIL, IF KNOWN, THE DISADVANTAGES OF THE CLOSEST PRIOR ART.

1. Fan Yang, X. Zhang, x Yee and Y. Rahmat-Samii, "Wide-Band E-Shaped Patch Antennas for Wireless Communications", IEEE Trans. On Antennas and Prop., Vol. 49, No. 7, July 2001, p. 1094-1100. This publication describes a dual resonance patch antenna. The antenna described in this publication does not provide an omnidirectional radiation pattern in the plane of the antenna that is polarized perpendicular to the plane of the antenna. Additionally, this antenna is considerably larger than the antenna described in this disclosure.

2. C. Delaveaud, P. Leveque and B. Jecko, "New kind of microstrip antenna: the monopolar wire-patch antenna", Electronics Letters, Vol. 30, No. 1, Jan. 6 1994, p. 1-2. First description of the center fed, short circuited patch antenna that generates a monopole pattern out of a patch that is under half the size of a traditional patch antenna. This antenna is not a dual frequency antenna.

3. E. Lee, P. S. Hall and P. Gardner, "Compact dual-band dual-polarization microstrip patch antenna", Electronic Letters, Vol. 35, No. 13, June 24, 1999, p. 1034-1035. This publication describes a shorted patch design that has a linear polarized monopole pattern at the lower resonance and a circular polarized patch antenna pattern at the upper resonance. Thus this antenna is not suitable to dual frequency terrestrial communication systems. The dual resonance is achieved by integrating a capacitor into the feeding probe.

4. Z. Liu, P. Hall and D. Wake, "Dual-Frequency Planar Inverted-F Antenna", IEEE Trans. on Antenna and Prop., Vol. 45, No. 10, Oct. 1997, p. 1451-1458. Describes a dual frequency PIFA. Although the PIFA pattern at both frequencies can be used for dual band terrestrial systems, the monopole/PIFA pattern of the antenna described in this disclosure is superior. Also, there is a limitation on the frequency separation that can be achieved with this design.

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

SIGNATURE OF INVENTOR		DATE		SIGNATURE OF INVENTOR		DATE		INVENTION DOCKET NO. RECEIVED HRL LABORATORIES, LLC 020603
SIGNATURE OF INVENTOR		DATE		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		DATE		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		DATE		SIGNATURE OF INVENTOR		DATE		

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE)	SIGNATURE	DATE	WITNESS NAME (TYPE)	SIGNATURE	DATE
JOE ORATOLINGO	<i>[Signature]</i>		JOE ORATOLINGO	<i>[Signature]</i>	

(EACH PAGE UPON WHICH INFORMATION IS ENTERED SHOULD BE SIGNED AND WITNESSED)

02001 HRL Laboratories, LLC. All rights reserved. Rev: 042591.

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



4 of 14

- E. IF PRIOR ART EXISTS, EXPLAIN WHY YOUR INVENTION IS NOT OBVIOUS IN LIGHT OF THE PRIOR ART. CONSIDER SUCH FACTORS AS UNEXPECTED RESULTS, COMMERCIAL SUCCESS OF THE INVENTION, A LONG- FELT NEED THAT IS SATISFIED BY THIS INVENTION, FAILURE OF OTHERS WHO HAVE TRIED TO MAKE THIS INVENTION OR SATISFY THE NEED, COPYING OF YOUR INVENTION BY OTHERS, LICENSING OF YOUR INVENTION AND SKEPTICISM BY THOSE EXPERT IN THE TECHNICAL FIELD OF THE INVENTION ABOUT THE FEASIBILITY OF THE INVENTION.

The antenna described in this disclosure is significantly different from the prior art mentioned in response 8D. This antenna is the combination of an inductively loaded center fed patch and a PIFA, none of the prior art attempts to address the problem of a dual frequency terrestrial communication system antenna with this unique combination of radiating elements.

9. DETAILED DESCRIPTION

DESCRIBE YOUR INVENTION IN DETAIL, EXPLAINING THE STRUCTURE OF THE APPARATUS OR DEVICE, INCLUDING MATERIALS USED, SIZES AND DIMENSIONS AND HOW COMPONENTS ARE CONNECTED AND EXPLAINING THE METHOD OF PERFORMING THE INVENTION, INCLUDING EACH OF THE STEPS NEEDED TO COMPLETE THE METHOD. MULTIPLE EMBODIMENTS OF THE INVENTION SHOULD BE IDENTIFIED; HOWEVER, IF MORE THAN ONE EMBODIMENT IS DISCLOSED, IDENTIFY WHICH IS THE PREFERRED EMBODIMENT. USE ADDITIONAL SHEETS AS NECESSARY.

- A. BE SURE THAT EACH SHEET IS DATED, AND SIGNED BY EACH INVENTOR AND TWO WITNESSES.
B. ATTACH COPIES OF DRAWINGS OR DETAILED REPORTS HELPFUL IN UNDERSTANDING HOW YOUR INVENTION WORKS.
C. IF YOUR INVENTION HAS BEEN TESTED, BRIEFLY SUMMARIZE THE TEST RESULTS WHICH CONFIRM THE FUNCTIONS AND ADVANTAGES LISTED IN 8 B ABOVE.

The antenna disclosed in this document is the combination of an inductively loaded center fed patch and PIFA. Figure 1 is a schematic of the antenna. Starting from a center fed patch inductively loaded with short circuits on either side of the feed as described in reference 2, one of the shorting strips was removed, and the fed and remaining shorting strip were recentered under the top plate. Next, two parallel slots were then introduced into the top plate, perpendicular to and on either side of the shorting strip. By introducing the slots, the region of the antenna between the slots functions, and looks, like a PIFA without affecting the operation of the inductively loaded center fed patch. The overall length of the top plate, labeled L_a in Figure 1, helps determine the resonant frequency of the inductively loaded center fed patch and the length of the center strip of metal in the top plate isolated by the slots, labeled L_b in Figure 1, determines the resonance frequency of the PIFA.

Figure 2 contains a plot of the computed input match of the combination antenna, which shows two distinct resonances, one at 900 MHz and one at 1.9 GHz. All the simulated results presented in this disclosure were

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	

INVENTION SOCKET NO.
RECEIVED
HRL LABORATORIES, LLC

020603

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE) ADG CRATION SIGNATURE [Signature] DATE [Date]
(EACH PAGE UPON WHICH INFORMATION IS ENTERED SHOULD BE SIGNED AND WITNESSED)

WITNESS NAME (TYPE) Don Greenier SIGNATURE [Signature] DATE [Date]
©2001 HRL Laboratories, LLC. All rights reserved. Rev. 042501.

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



2 of 14

generated using the Zeland IE3D method of moments software package. A prototype of the structure shown in Figure 1 was built and pictures of the prototype are shown in Figure 2. Figure 1 contains a plot of the measured input match of the prototype antenna that shows the predicted dual band resonance of the structure. The measured data shows good agreement with the computed results.

Figure 4 contains computed directivity pattern plots at 900 MHz: upper left column elevation pattern in the $\phi = 0$ degree plane; upper right column elevation pattern in the $\phi = 90$ degree plane; bottom row azimuth pattern in the $\theta = 90$ degree plane. The pattern plots use the common spherical coordinate definitions of θ being the angle from the positive z-axis and ϕ being the counter clockwise angle from the x-axis in the x-y plane. The radiation patterns shown in Figure 4 are very similar to a monopole pattern. Figure 5 contains computed directivity pattern plots at 1.9 GHz: upper left column elevation pattern in the $\phi = 0$ degree plane; upper right column elevation pattern in the $\phi = 90$ degree plane; bottom row azimuth pattern in the $\theta = 90$ degree plane. The radiation patterns shown in Figure 5 are characteristic of the PIFA. Based on the data presented in Figures 4 and 5, it can be seen that this dual band antenna operates as a center fed patch at the lower resonance and as a PIFA at the upper resonance. The radiation characteristics of this antenna satisfy the needs of most terrestrial communication systems at both resonances; vertically polarized, omnidirectional radiation in the azimuthal plane.

To illustrate the independence of the resonances of this structure, consider the data presented in Figure 6. The data presented in this plot is computed data for the structure illustrated in Figure 1 as the dimension L_b is varied from 28 mm to 53 mm with all other dimensions fixed. From the computed results shown in Figure 6 it can be seen that varying the length of the center finger of metal changes the PIFA resonance with almost no affect on the center fed patch resonance. For the specified range of L_b , the higher frequency resonance was moved from 2.75 GHz to 1.6 GHz. The input match at the extremes of the range could be improved by changing the feed and short circuit locations, although doing so would affect the center fed patch resonance.

In Figure 7 is a plot of computed match data for the structure shown in Figure 1 as the dimension L_a is varied from 35.5 mm to 95 mm with all other dimensions fixed. From the computed results shown in Figure 7 it can be seen that varying the length of the entire top metal piece changes the center fed patch resonance with almost no affect on the PIFA resonance. For L_a equal to 35.5 mm there is only a 0.5 mm wide strip connecting the three strips of metal together and at 95 mm the top plate is the same length as the ground plane. For this range of L_a , the lower frequency resonance is moved from 1.05 GHz to 800 MHz.

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		INVENTION DOCKET NO. RECEIVED HRL LABORATORIES, LLC 020603
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE) ADG ORATON30 SIGNATURE [Signature] DATE [Date]

WITNESS NAME (TYPE) Don Gregoire SIGNATURE [Signature] DATE [Date]

©2001 HRL Laboratories, LLC. All rights reserved. Rev: 042501.

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



2 of 14

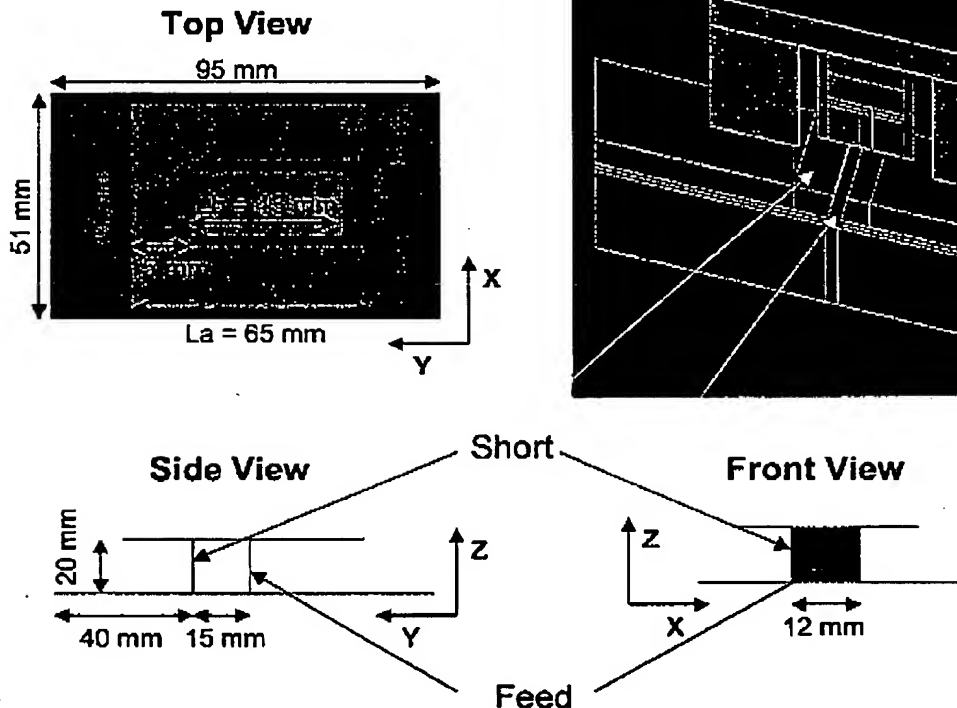


Figure 1: Schematics of the dual band center fed patch/PIFA.

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	

INVENTION DOCKET NO. _____
RECEIVED
HRL LABORATORIES, LLC

020603

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE)		SIGNATURE		DATE	
ADE ORATYIN 30		[Signature]		[Date]	

WITNESS NAME (TYPE)		SIGNATURE		DATE	
[Name]		[Signature]		[Date]	

©2001 HRL Laboratories, LLC. All rights reserved. Rev: 042501.

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



9 of 14

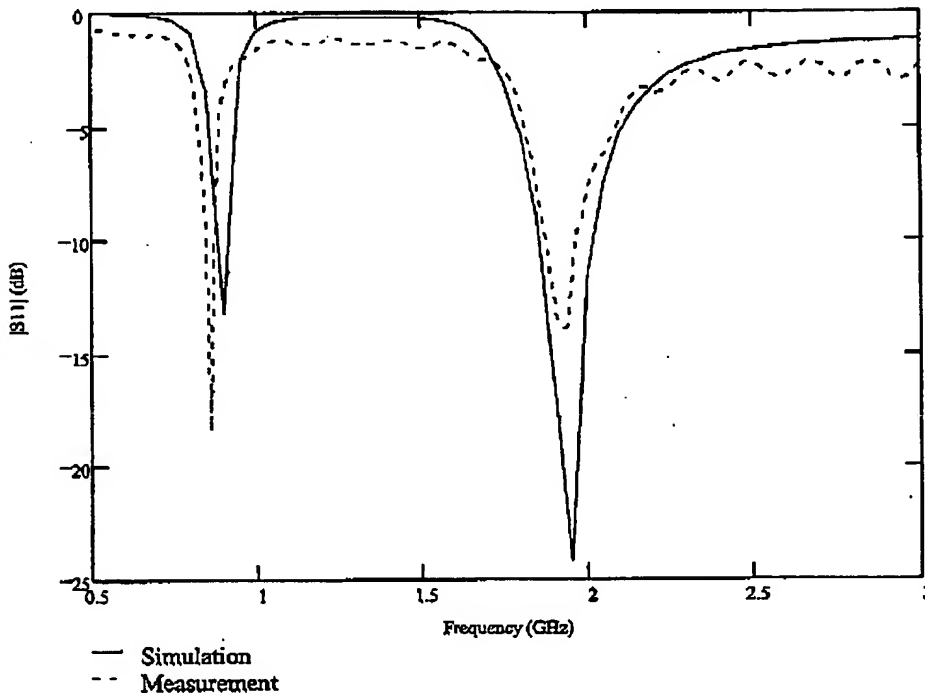


Figure 2: Simulated and measured dual resonance of the center fed patch/PIFA.

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		INVENTION DOCKET NO. HRL LABORATORIES, LLC 020603
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE) AGE ORATOVES SIGNATURE [Signature] DATE [Date]
 (EACH PAGE UPON WHICH INFORMATION IS ENTERED SHOULD BE SIGNED AND WITNESSED)

WITNESS NAME (TYPE) Don Greco SIGNATURE [Signature] DATE [Date]

WITNESS NAME (TYPE) [Signature] SIGNATURE [Signature] DATE [Date]
 ©2001 HRL Laboratories, LLC. All rights reserved. Rev 042501.

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



10 of 14

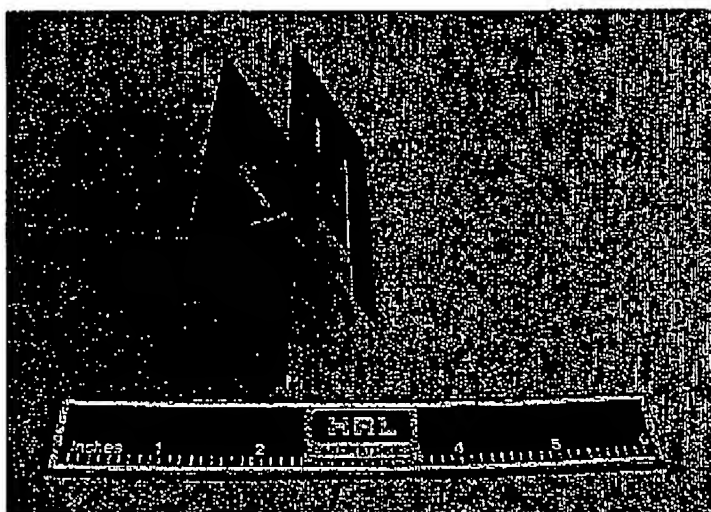
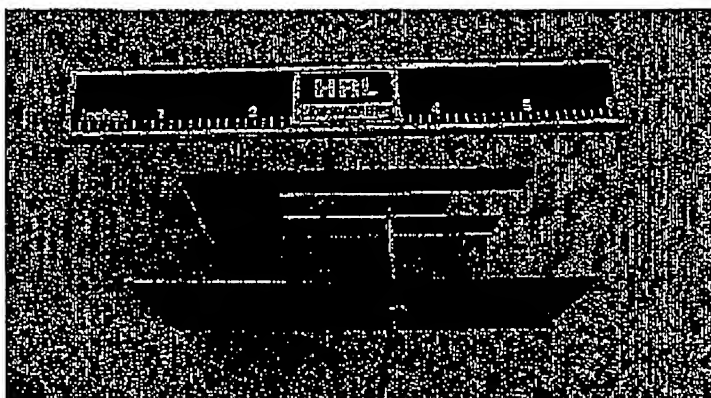


Figure 3: Pictures of prototype center fed patch/ PIFA.

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR		INVENTION DOCKET NO. RECEIVED HRL LABORATORIES, LLC	
 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR	
SIGNATURE OF INVENTOR DATE		SIGNATURE OF INVENTOR DATE		SIGNATURE OF INVENTOR DATE	
SIGNATURE OF INVENTOR DATE		SIGNATURE OF INVENTOR DATE		SIGNATURE OF INVENTOR DATE	

READ AND UNDERSTOOD BY:

ADG OBATOZINEO

SIGNATURE DATE

WITNESS NAME (TYPE)

SIGNATURE DATE

(EACH PAGE UPON WHICH INFORMATION IS ENTERED SHOULD BE SIGNED AND WITNESSED)

©2001 HRL Laboratories, LLC. All rights reserved. Rev: 042501

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



11 of 14

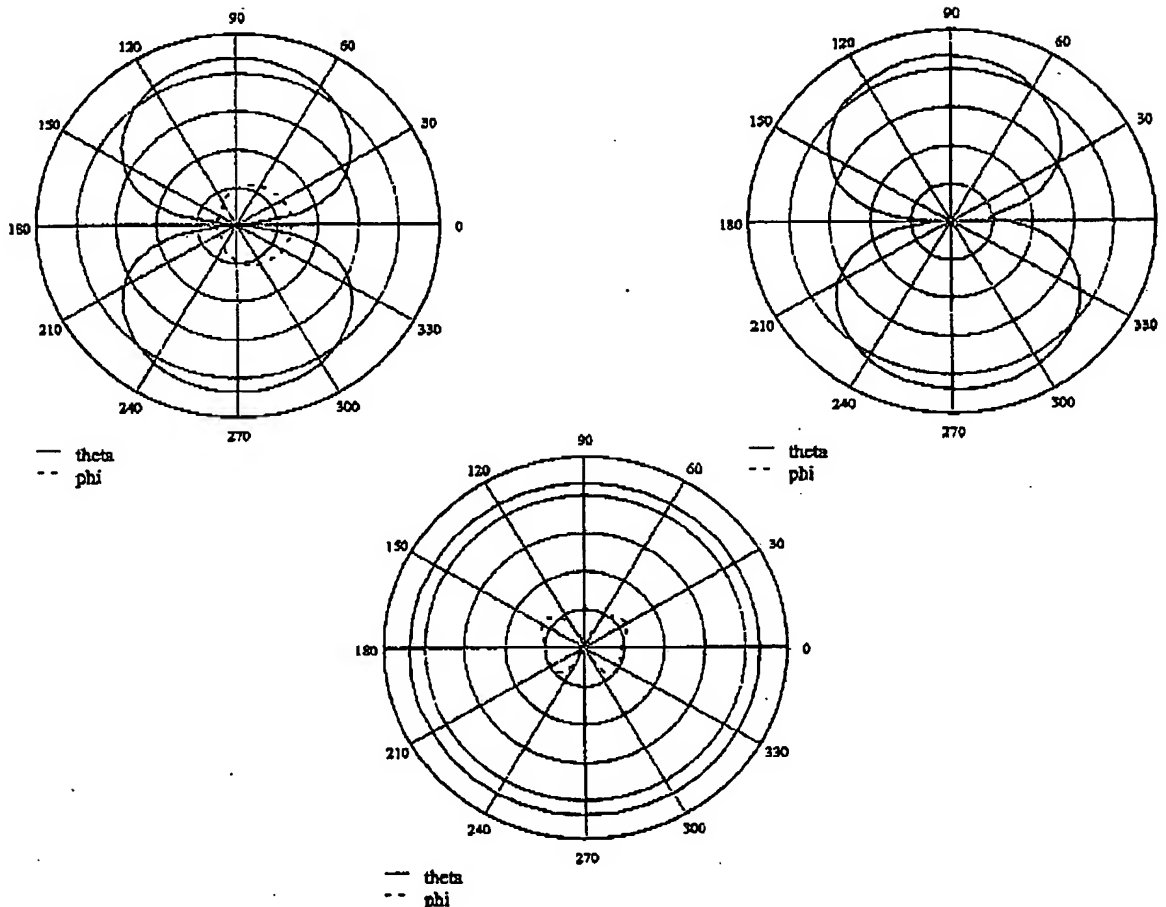


Figure 4: Computed directivity patterns of the center fed patch/PIFA at 900 MHz; upper left corner phi = 0 deg. plane; upper right corner phi = 90 deg. plane; bottom row theta = 90 deg. plane. The outer radius is 5 dB and the scale is 5 dB per division.

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

		SIGNATURE OF INVENTOR		DATE
		SIGNATURE OF INVENTOR		DATE
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE

INVENTION DOCKET NO.
RECEIVED
HRL LABORATORIES, LLC

020603

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE)	SIGNATURE DATE
ADE Cbatoywbo	

(EACH PAGE UPON WHICH INFORMATION IS ENTERED SHOULD BE SIGNED AND WITNESSED)

WITNESS NAME (TYPE) SIGNATURE DATE

©2001 HRL Laboratories, LLC. All rights reserved. Rev. 042501.

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



12 of 14

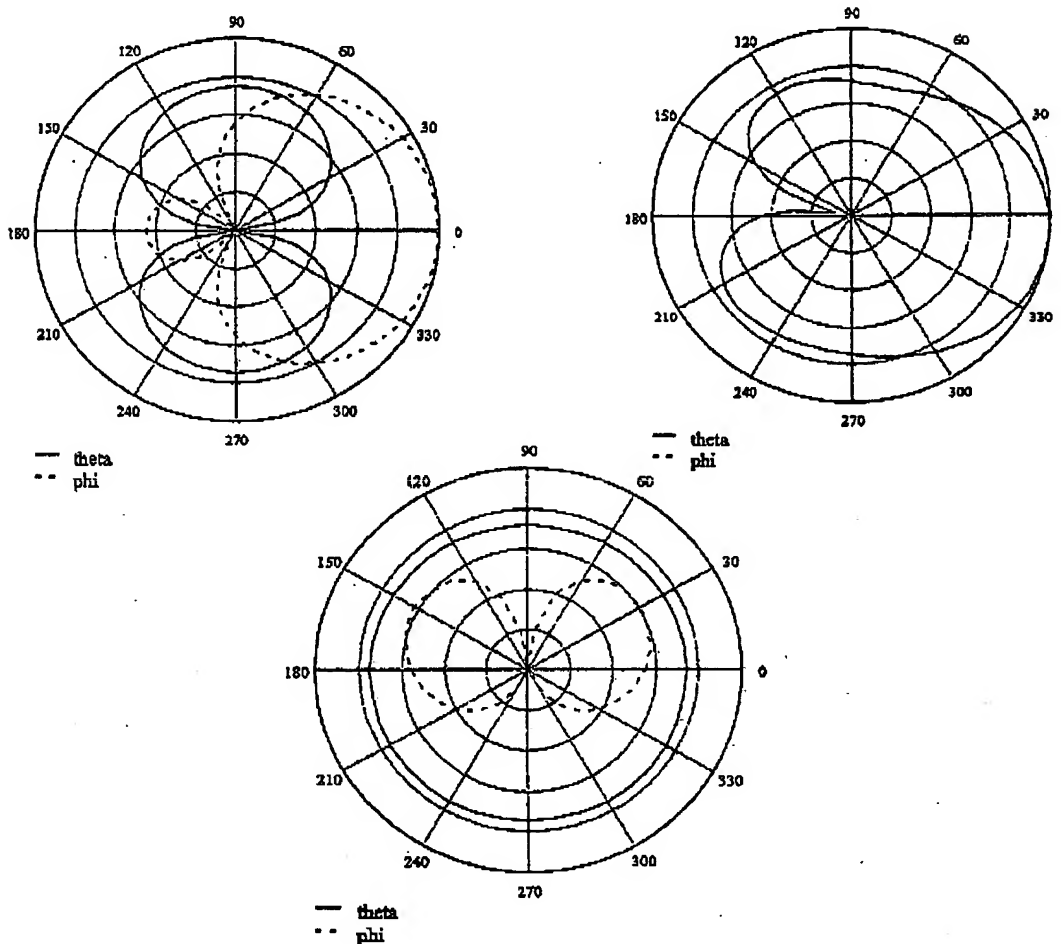


Figure 5: Computed directivity patterns of the center fed patch/PIFA at 1.9 GHz; upper left corner phi = 0 deg. plane; upper right corner phi = 90 deg. plane; bottom row theta = 90 deg. plane. The outer radius is 5 dB and the scale is 5 dB per division.

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR		INVENTION DOCKET NO. RECEIVED HRL LABORATORIES, LLC 020603	
 SIGNATURE OF INVENTOR		 SIGNATURE OF INVENTOR			
SIGNATURE OF INVENTOR DATE		SIGNATURE OF INVENTOR DATE			
SIGNATURE OF INVENTOR DATE		SIGNATURE OF INVENTOR DATE			

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE)
ADE OBAYOINBO

WITNESS NAME (TYPE)
[Signature]

WITNESS NAME (TYPE)
[Signature]

WITNESS NAME (TYPE)
[Signature]

(EACH PAGE UPON WHICH INFORMATION IS ENTERED SHOULD BE SIGNED AND WITNESSED)

©2001 HRL Laboratories, LLC. All rights reserved. Rev. 042501.

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



13 of 14

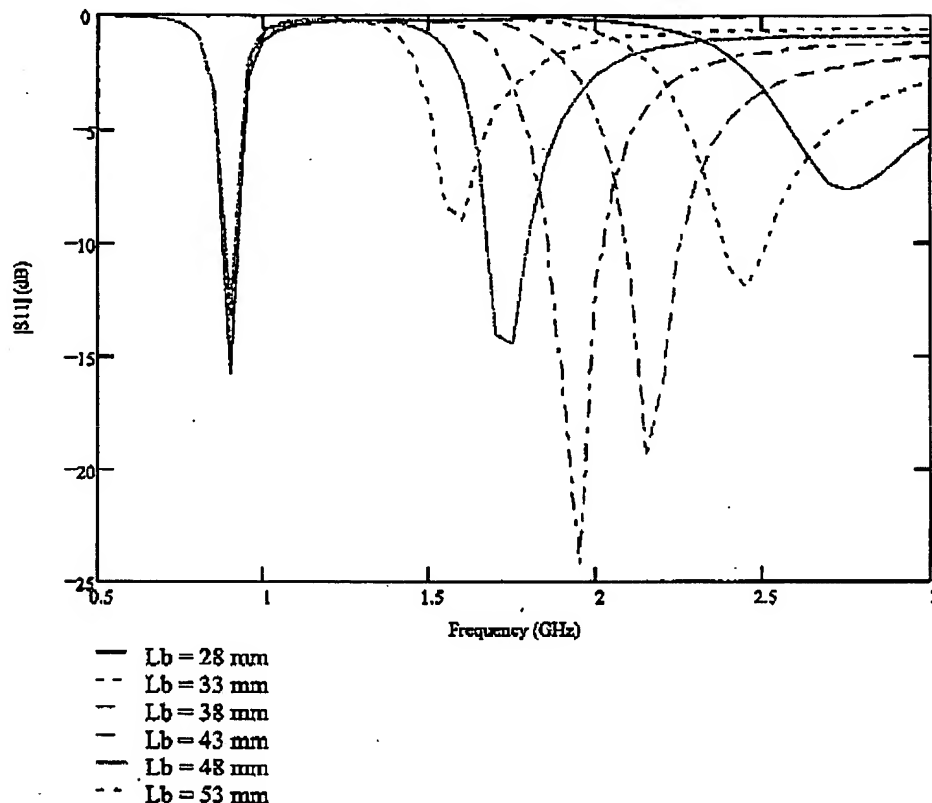


Figure 6: Computed match of the center fed patch/PIFA holding the dimension L_a fixed and varying the dimension L_b from 28 mm to 53 mm. By varying L_b over the specified range the upper frequency resonance can be moved from 2.75 GHz to 1.6 GHz.

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE	

INVENTION DOCKET NO.
RECEIVED
HRL LABORATORIES, LLC

020603

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE) ADG OBAOYINBO SIGNATURE [Signature] DATE [Date]

WITNESS NAME (TYPE) [Signature] SIGNATURE [Signature] DATE [Date]

©2001 HRL Laboratories, LLC. All rights reserved. Rev. 042501.

SEND COMPLETED DISCLOSURE DIRECT TO:
TECHNOLOGY INFORMATION OFFICE
ATTN: Joy Pavlow, MS RL55
HRL LABORATORIES, LLC
Telephone No - 5734

HRL PROPRIETARY AND SENSITIVE
(when completed)
INVENTION DISCLOSURE
THIS INVENTION DISCLOSURE IS MADE PURSUANT TO
MY / OUR OBLIGATIONS TO HRL LABORATORIES, LLC



14 or 14

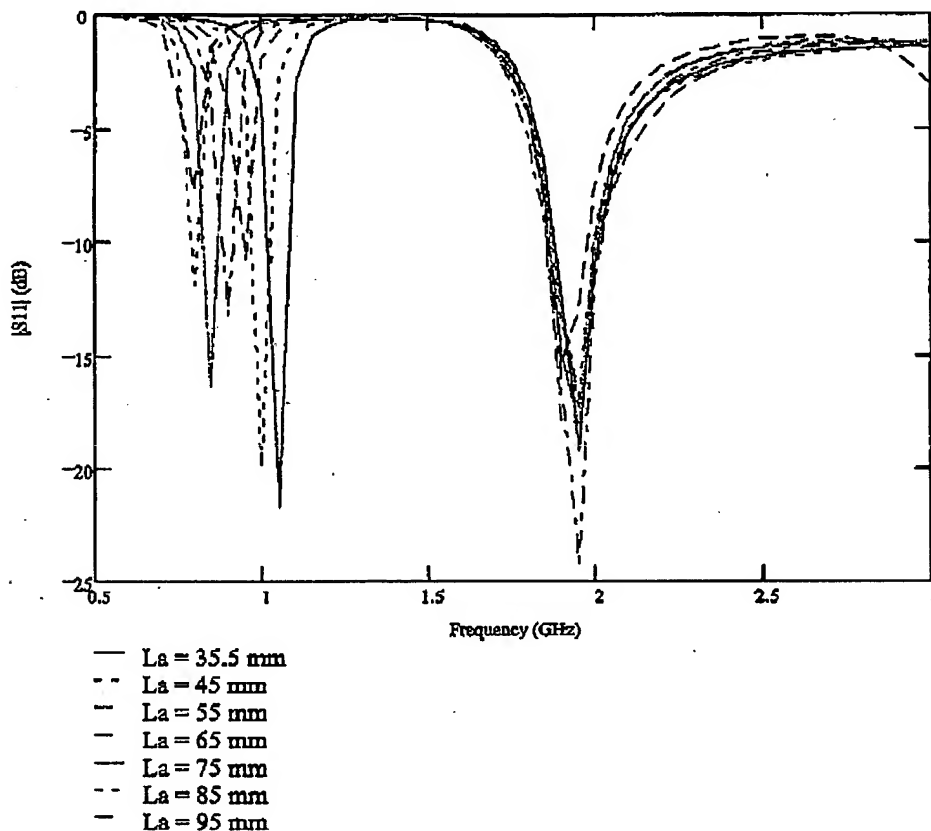


Figure 7: Computed match of the center fed patch/PIFA as L_b is held fixed and L_a is varied from 35.5 mm to 95 mm. By varying L_a over the specified range, the lower frequency resonance can be varied from 1.05 GHz to 800 MHz

HRL PROPRIETARY AND SENSITIVE (when completed)

THIS DOCUMENT CONTAINS PROPRIETARY INFORMATION, AND EXCEPT WITH WRITTEN PERMISSION OF HRL LABORATORIES, LLC, SUCH INFORMATION SHALL NOT BE PUBLISHED, OR DISCLOSED TO OTHERS, OR USED FOR ANY PURPOSE, AND THE DOCUMENT SHALL NOT BE DUPLICATED IN WHOLE OR IN PART. THIS LEGEND SHALL BE APPLIED TO ALL DOCUMENTS CONTAINING THIS INFORMATION.

SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		INVENTION DOCKET NO. RECEIVED HRL LABORATORIES, LLC 020603
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		
SIGNATURE OF INVENTOR		SIGNATURE OF INVENTOR		DATE		

READ AND UNDERSTOOD BY:

WITNESS NAME (TYPE) SIGNATURE DATE
 ADE OBOYINBO [Signature] [Date]

WITNESS NAME (TYPE) SIGNATURE DATE
 Dan Green [Signature] [Date]

©2001 HRL Laboratories, LLC. All rights reserved. Rev. 04/2001.

**This Page is Inserted by IFW Indexing and Scanning
Operations and is not part of the Official Record**

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☐ BLACK BORDERS
- ☐ IMAGE CUT OFF AT TOP, BOTTOM OR SIDES
- ☐ FADED TEXT OR DRAWING
- ☐ BLURRED OR ILLEGIBLE TEXT OR DRAWING
- ☐ SKEWED/SLANTED IMAGES
- ☐ COLOR OR BLACK AND WHITE PHOTOGRAPHS
- ☐ GRAY SCALE DOCUMENTS
- ☒ LINES OR MARKS ON ORIGINAL DOCUMENT
- ☐ REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY
- ☐ OTHER: _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.